Image De-Noising using Low Rank Matrix Decomposition, SVM and ACO

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Abstract - Parallel magnetic resonance imaging (pMRI) techniques can accelerate MRI scan through a multi-channel coil cluster tolerating signal simultaneously. The noise amplification and aliasing artifacts are serious in pMRI recreated images at high increasing velocities. This study exhibits a patch-wise de-noising method for pMRI by misusing the rank insufficiency of multi-Channel coil images and sparsity of artifacts. For every processed patch and similar patches a researched in spatial domain and through-out all coil components and organized in appropriate matrix forms. At that point noise and aliasing artifacts are expelled from the organized Matrix by applying sparse and low rank matrix decomposition technique. The proposed technique has been acknowledged utilizing both phantom and in vivo brain data sets creating empowering results. Specifically the procedure can successfully remove both noise and residual aliasing artifact from pMRI remade noisy images and create higher peak signal noise rate (PSNR) and structural similarity index matrix (SSIM) than other state-of-the-art De-noising methods. We propose image de-noising using low rank matrix decomposition, SVM and ACO.

Keywords - *De-noising, Low Rank Matrix, Decomposition, SVM and ACO.*

I. INTRODUCTION

Image processing is a type of sign handling for which the info is an image. For example, a photo or feature edge and the yield of image transforming may be either an image or the image parameters. Image is a two dimensional capacity of two genuine variables. Image= f(x, y) where, x and y are the spatial directions known as pixels and f is the abundance. In the recent past, transforming an image is changed over into the advanced structure. The digitization incorporates; inspecting of images and quantization of the examined qualities. In this way in the wake of changing over the image into bit data the preparing is performed. The processing method may be image upgrade; image reproduction and image pressure.

De-noising in magnetic resonance imaging (MRI) is a basic issue and imperative for clinical finding and modernized examination. Increasing the strength of magnetic fields can improve the signal-noise-ratio (SNR) but it will introduce radio frequency in homogeneity artifacts and demand high costs because the noise attenuation requires high power supply devices to increase the super conduction effect. Using a multi-channel coil array to simultaneously receive MR k-space (i.e., the spatial Fourier transform domain of imaging object) signals shows significant SNR gain. More-over, additional k-space data from these coils can be used to fill uniformly under sampled k-space by utilizing parallel MRI (pMRI) techniques that can shorten MR scanning time. The noise amplification and aliasing artifacts are serious in pMRI remade image at high under sampling factors Therefore, it is necessary to introduce a denoising procedure to improve the quality of pMRI image.

A. Low-Rank Matrix Decomposition

It is derived from com-pressed sensing theory has been successfully applied various matrix completion problems, e.g., image compression video denoising and dynamic MRI Compared with classical denoising methods. Denoising methods based on low rank completion enforce fewer external assumptions on noise distribution. These methods rely on the self-similarity of three dimensions (3-D) images across different slices or frames to construct a low rank matrix. Nonetheless, significantly varying contents between different slices or frames may lead an exception to the assumption of low-rank 3-D images, and discount the effectiveness of these methods. In this paper, we propose to remove both noise and aliasing artifacts in pMRI image by using a sparse and low rank decomposition method. By exploiting the self-similarity between multi-channel coil images and inside themselves, we formulated the denoising of pMRI image as a non-smooth convex optimization problem that minimizes a combination of nuclear norm and L1norm. The proposed problem is efficiently solved by using the alternating direction method of multipliers (ADMM). Experimental results of phantom and in vivo brain imaging are provided to demonstrate the performance of the proposed method, with comparisons to the related denoising methods.

B. Support Vector Machine (SVM)

It is basically a classifier in which Width of the edge between the classes is the advancement standard that is unfilled zone around the decision boundary characterized by the separation to the closest training patterns. These are called support vectors. The support vectors change the models with the main difference between SVM and traditional template matching systems is that they characterize the classes by a decision limit. This decision boundary is not simply characterize by the minimum distance function. The concept of (SVM) Support Vector Machine was introduced by Vapnik. The objective of any machine that is capable of learning is to achieve good generalization performance, given a finite amount of training data. The support vector machines have proved to achieve good generalization performance with no prior knowledge of the data. The principle of an SVM is to map the input data onto a higher dimensional feature space nonlinearly related to the input space and determine a separating hyper plane with maximum margin between the two classes in the feature space. The SVM is a maximal margin hyper plane in feature space built by using a kernel function. This results in a nonlinear boundary in the data space. The optimal separating hyper plane can be determined without any computations in the higher dimensional feature space by using kernel functions in the input space. There are some commonly used kernels include:-

a) Linear Kernel K(x, y) = x, y

b) Polynomial Kernel K(x, y) = (x. y+1) d

SVM Algorithm

i. Define an optimal hyper plane.
ii. Extend the above definition for nonlinear separable problems.
iii. Map data to high dimensional space where it is simpler to order with direct choice surfaces.

C. Ant Colony Optimization (ACO)

Ant Colony Optimization (ACO) is a standard for planning Meta heuristic algorithms for combinatorial optimization problems. A Meta heuristic is situated of algorithmic ideas that can be used to characterize heuristic methods applicable to a wide set of different issues. In other words, a Meta heuristic is a general-purpose algorithmic framework that can be applied to different optimization problems with moderately few modifications. Illustrations of Meta heuristics include simulated annealing, tabu search and iterated local search and evolutionary computation and ant colony optimization.

Meta heuristic calculations are calculations which, so as to escape from nearby optima, drive some essential heuristic: either a useful heuristic beginning from an invalid arrangement and adding components to assemble a decent finish one, or a neighborhood seek heuristic beginning from a complete arrangement and iteratively adjusting some of its components with a specific end goal to attain to a superior one. The Meta heuristic part allows the low-level heuristic to acquire arrangements better than those it could have attained to alone, regardless of the fact that iterated. Ordinarily, the controlling system is attained to either via compelling or by randomizing the set of nearby neighbor answers for consider in neighborhood seeks.

ACO is a class of calculations, whose first part, called Ant System, was at first proposed by Colorni, Dorigo and Maniezzo. The primary hidden thought, inexactly propelled by the conduct of genuine ants, is that of a parallel hunt over a few valuable computational strings in light of nearby issue information and on an element memory structure containing data on the nature of already acquired result.

Advantages of ACO

1. Inherent parallelism
2. Positive Feedback accounts for rapid discovery of good solutions
3. Efficient for Travelling Businessperson Problem and comparative issues
4. Can be utilized in dynamic applications

Disadvantages of ACO

1. Theoretical analysis is difficult
2. Sequences of random decisions (not independent)
3. Likelihood dissemination changes by emphasis
4. Examination is exploratory rather than theoretical
5. Time to convergence uncertain (but convergence is guaranteed!)

II. PREVIOUS WORK

A. Lin Xu, Changqing Wang, Wufan Chen, and Xiaoyun Liu, IEEE 2014

In this paper, Parallel magnetic resonance imaging (pMRI) methods can accelerate MRI examine through a multi-channel coil array accepting signal at the same time. The noise amplification and aliasing artifacts are serious in pMRI reproduced images at high expanding speed. This study shows a patch-wise denoising method for pMRI by misusing the rank inadequacy of multi-channel coil images and sparsity of artifacts. For each prepared patch similar patches a researched in spatial domain and throughout all coil elements and arranged in suitable lattice structure. At that point noise and aliasing artifacts are expelled from the structured matrix by applying sparse and low rank matrix decomposition procedure. The proposed technique has been accepted utilizing both phantom and in vivo brain data sets and creating empowering results. The system can successfully remove both noise and residual aliasing artifact from pMRI reconstructed noisy images and produce higher peak signal noise rate (PSNR) and structural similarity index matrix (SSIM) than other state-of-the-art denoising methods.

B. Abha Choubey, Dr. G.R.Sinha, Siddhartha Choubey, IEEE 2011

In this paper, image processing accept a crucial part in the medical field because most of the diseases are diagnosed by method of medical images. To utilize these images for the diagnosing methodology and it must be a noiseless one. Regardless the larger part of the images are affected through noises and artifacts caused by the different acquisition techniques and thus an Effective technique for denoising is important for medical images especially in Computed Tomography which is a significant and most general modality in medical imaging. To attain this denoising of CT images a compelling CT image denoising method is proposed. The proposed work is comprised of three stages are Preprocessing and training and testing. The CT image which is influenced by the AWGN noise is changed utilizing multi wavelet transformation in the preprocessing stage. The got multi-wavelet coefficients are given as input to the Adaptive Neuro-Fuzzy Inference System (ANFIS) in the training stage. The input CT image is examined utilizing this trained ANFIS and then to enhance the quality of the CT image thresholding is applied and at that point the image is reproduced in the testing stage. Thus the denoised and the quality enhanced CT images are got in a successful way.

C. Afandi Ahmad, Janifal Alipal, Noor Huda, Ja'afar, Abbes, IEEE 2012

This paper introduced a productive analysis in view of goal and subjective test for filtering methods of the adaptive non-linear thresholding area in discrete wavelet transform (DWT). The ultrasound images have been caught from three region-of-interests (ROIs) which are stomach and neck and chest. These images have been changed over into grayscale and three types of noises have been included including Speckle and Gaussian and Salt & Pepper. The visual impact has been measured utilizing an investigation of image specialists for de-noised image then yields the information of subjective test in terms of mean-opinion-score (MOS). This project succeeds to investigate another thresholding procedure with better execution in both SNR and visual impact named as hybrid estimated threshold (HET). It uncovers that HET is the best filtering procedure to evacuate the Speckle, Gaussians and Salt & Pepper noise.

III. CONCLUSION

We have described a novel denoising method for pMRI by exploiting the self-similarity between multi-channel coil images and inside themselves. The proposed method simultaneously removes noise and aliasing artifacts by leveraging sparse and low rank matrix factorization. Experimental results demonstrate that the proposed algorithm can benefit both visual diagnostic and quantitative methodologies. The proposed method could be extended to multiple dimensions imaging by exploiting the redundancy and similarity between multi-slice and multi-frame images to achieve a higher SNR gain that is warranted in a future study.

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